THE GROWTH OF THE HEAD CAPSULE IN THE SUCCESSIVE INSTARS IN INDIVIDUAL LARVAE OF *GRAPHIUM SARPEDON NIPPONUM* FRUHSTORFER (LEPIDOPTERA: PAPILIONIDAE)

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A Papilionid butterfly *Graphium sarpedon nipponum* Fruhstorfer is commonly found in the Pacific coast of Central Japan and southward. Larvae thrive on Lauraceous plants, such as *Cinnamomum Camphora* Sieb., *C. Loureirii* Nees, *C. japonicum* Sieb., *Litsea aciculata* Blume, *L. glauca* Sieb., and *Machilum Thunbergii* Sieb. et Zucc. In Central Japan, two generations are usually repeated per year, and overwintering is done at the pupal stage. Adults of the first brood (vernal form) appear in April-June and those of the second brood (aestival form) in July-August. This life cycle, however, is not always constant. Adults of the next brood are found quite often within the year. The present writers have carried out an individual rearing experiment of the materials collected in the summer of 1973. This short report deals with the growth of the head capsule in the successive instars of these larvae.

The eggs were collected on leaves of *C. japonicum* from the field in Shimizu City, Shizuoka Prefecture. Hatched larvae were reared individually under a laboratory condition using polyethylene ice cream cups of 9 cm in diameter and 4 cm in depth. Temperature and humidity were not controlled. Leaves of *C. japonicum* were given as diet, and the exuviae of head capsule were collected and kept for each larva. Later the maximum width of head capsule was measured by the scale on the display glass plate of the projector microscope.

In the present rearing experiment, 9 females and 8 males completed their development to the pupal stage. These sexes were determined by the emerged adults or dissection of pupae since some adults emerged from them soon after pupation and the rest entered into diapause. The latter individuals are asterisked in table 1. The results of measurement y shown in table 1 are the maximum width mm $\times$ 10 in logarithms. The analysis of variance of the data was conducted by the computing instructions given elsewhere (Bliss, 1967). The results show marked differences in the width of head capsule of the individual larvae over all the instars (row 1) for both female and male series. But quadratic terms and others excepting the linear trends were not significant. Consequently the relations between the log-width of the head capsule Y and the instar numbers X could be expressed with simple linear equations. This simple linear relation has been known as Dyar's rule for expressing the growth of the head capsule in the successive instars in lepidopterous larvae. The calculated equations are $Y=1.29802+0.18313(X-3)$ for female and $Y=1.29055+0.18030(X-3)$ for male series. The result of analysis of variance conducted about the average figures of female and male series showed significance in discrepancy between the growths of the head capsule in female and male, $F_{\mathrm{cal}}=12.08>F_3{}^1\ (P_r=0.05)=10.1$, and the growth of the width of head capsule in females is little larger than that in males. The similar analysis was conducted about the average figures of non-diapausing and diapausing individuals. The result showed significance in discrepancy between the growths of their head capsules, $F_{\mathrm{cal}}=13.57$ in female and 820.00 in male. The growth of the width of head capsule in the non-diapausing individuals is significantly larger than that of the diapausing individuals.

References

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Dyar, H.G. (1890) The number of moults of lepidopterous larvae. *Psyche* 5: 420—422.

Table 1. Log-width y=log mm+1, of the head capsule in successive instars x of larvae of *Graphium sarpedon nipponum* Fruhstorfer.

Sex	Larva No.	Width in logarithms y for instar					Lava total	Regression on instar	
		I	II	III	IV	V	T_g	$\Sigma(x_1y)$	$\Sigma(x_2y)$
Female	1	0.934	1.121	1.342	1.521	1.672	6.590	1.876	−0.114
	2	0.934	1.140	1.305	1.480	1.667	6.526	1.806	−0.028
	3	0.924	1.100	1.292	1.459	1.653	6.428	1.817	0.011
	4	0.934	1.114	1.305	1.480	1.677	6.510	1.852	0.018
	5	0.934	1.114	1.310	1.486	1.677	6.521	1.858	0.002
	6	0.924	1.114	1.297	1.474	1.672	6.481	1.856	0.010
	7	0.924	1.114	1.305	1.483	1.672	6.498	1.865	−0.015
	8*	0.924	1.121	1.301	1.474	1.653	6.473	1.811	−0.043
	9*	0.924	1.107	1.265	1.435	1.653	6.384	1.786	0.082
	T_t	8.356	10.045	11.722	13.292	14.996	58.411	16.527	−0.077
	$\bar{y}_t$	0.929	1.117	1.303	1.477	1.667	B_1=0.18363		
	Y	0.930	1.114	1.298	1.482	1.665			
Male	1	0.934	1.114	1.279	1.480	1.667	6.474	1.832	0.050
	2	0.934	1.134	1.301	1.468	1.648	6.485	1.762	−0.040
	3	0.934	1.114	1.314	1.496	1.662	6.520	1.838	−0.046
	4*	0.924	1.114	1.305	1.480	1.667	6.490	1.852	−0.022
	5*	0.924	1.100	1.288	1.465	1.628	6.405	1.773	−0.037
	6*	0.924	1.107	1.279	1.456	1.648	6.414	1.797	0.023
	7*	0.924	1.114	1.279	1.468	1.662	6.447	1.830	0.032
	8*	0.924	1.107	1.279	1.459	1.618	6.387	1.740	−0.040
	T_t	7.422	8.904	10.324	11.772	13.200	51.622	14.424	−0.080
	$\bar{y}_t$	0.928	1.113	1.291	1.473	1.650	B_1=0.18030		
	Y	0.930	1.110	1.291	1.471	1.651			
	x_1	−2	−1	0	1	2			
	x_2	2	−1	−2	−1	2			

Table 2. Analysis of variance of the larva measurements in table 1.

Sex	Row	Term	DF	SS	MS×10^6	F
Female	1	Between larva totals	8	0.005635	704.4	5.66
	2	Trend on instar, B_c^2	1	3.034909	3,034,909.0	
	2′	Curvature, Q_c^2	1	0.000047	47.0	0.38
	3	Scatter about parabola	2	0.000416	208.0	1.67
	4	Larvae × linear trend	8	0.000796	99.5	0.80
	4′	Larvae × curvature	8	0.001605	200.6	2.32
	5	Larvae × scatter	16	0.001383	86.4	
	6	Total	44	3.044791		
	7	Correction, C_m	1	75.818776		
	8	Pooled error	24	0.002988	124.5	
Male	1	Between larva totals	7	0.003108	444.0	5.88
	2	Trend on instar, B_c^2	1	2.600647	2,600,647.0	
	2′	Curvature, Q_c^2	1	0.000057	57.0	0.75
	3	Scatter about parabola	2	0.000057	28.5	0.38
	4	Larvae × linear trend	7	0.001178	168.3	2.23
	4′	Larvae × curvature	7	0.000802	114.6	2.05
	5	Larvae × scatter	14	0.000783	55.9	
	6	Total	39	2.606632		
	7	Correction, C_m	1	66.620772		
	8	Pooled error	21	0.001585	75.5	